The objective of this study was to determine the effect of irrigation on in situ starch digestibility (ISSD) of corn for silage. The study was performed in Kimberly (ID) during the 2018 growing season. Five commercial corn hybrids were planted in a split-plot within a randomized complete block design with 4 blocks. Experimental treatments consisted of a control treatment with furrow irrigation at planting and 3 more times during crop growth (watered, W) and a non-irrigated treatment with furrow irrigation only at planting (drought, D). When the corn was between 1/4 and 3/4 milk-line stage of maturity, ears from 3 plants were harvested from each plot and shed by hand. After drying (55°C) to constant weight, kernels were ground to pass through a 4-mm screen of a cyclone mill before starch analysis. In situ starch dis-weighed and opened, and the residues were re-ground to pass through a 1-mm screen of a cyclone mill before starch analysis. In situ starch digestion rate. Undigestible starch (C) was also determined.

In conclusion, under the conditions of this study, the fractional starch digestion rate (6.7%/h; P < 0.05), or the half-life of starch (0.21). In conclusion, under the conditions of this study, the fractional starch digestion rate (6.7%/h; P < 0.05), or the half-life of starch (0.21).
Our objective was to evaluate the effects of an optimized lignosulfonate-based product (LST, UMaine), chitosan (ChNv, Sigma-Aldrich), and propionic acid (PRP, 99%; MP Biomedicals) on high-moisture alfalfa hay spoilage. Treatments were the factorial combination of 3 preservatives (LST, ChNv, and PRP) and 5 concentrations (0, 0.25, 0.5, 1, and 2% wt/wt fresh basis). Preservatives were added to 35 fresh g of sterile alfalfa hay (71.5 ± 0.23% DM), inoculated with a mixture of previously isolated spoilage fungi (5.27 log cfu/fresh g), and aerobically incubated in vitro for 23 d (25°C). Data were analyzed as a randomized complete block design replicated 5 times (5 independent plots from an alfalfa field) and differences were declared at \( P \leq 0.05 \). At d 0, the untreated hay had 43.9 ± 2.48, 19.7 ± 1.65, and 11.3 ± 0.17 of NDF, CP, and ash (% of DM), respectively. At d 23, relative to untreated (24.0 ± 0.45%), DM losses were greatly lessened by doses as low as 0.25% for both LST and PRP (~1.61). This was explained by reduced mold counts for as low as 1% LST (<2.0 log cfu/fresh g) and as low as 0.5% PRP (<2.0) vs untreated (6.76). Yeast counts were reduced by as low as 1% LST (<2.0) and as low as 0.25% PRP (<2.0) vs. untreated (6.10). Both as low as 0.25% LST and PRP prevented the decrease in DM (~62.5 ± 0.48%, 15.3 ± 0.12 and 24.1 ± 0.27% of DM). NH\(_3\)N was decreased by as low as 0.25% for both LST and PRP (~1.11 ± 0.77), and lower DM (~21.7) than PRP (23.6 ± 0.33%). CP was lower for PRP, NaL1, and NaL2 (~24.5 ± 0.42% of DM) compared with CON (27.4), and NH\(_3\)N (% of N) was higher for PRP and INO (~0.84) relative to other TRT (~0.50 ± 0.057). No major differences were observed for yeast (~4.27 ± 0.366) and mold (~2 log cfu/g fresh g) counts. Aerobic stability (h) was greater for NaL2 (103.2) relative to PRP (61.9) but no differences were observed vs. CON (90.1 ± 8.86). In conclusion, PRP preserved WBG nutrients during storage to the greatest extent, compared with the other preservatives tested.

**Key Words:** wet brewer’s grain, silage, preservatives

### 250 An optimized lignosulfonate-based product matched propionic acid preservation effects on high-moisture alfalfa hay, A. Y. Le-on-Tinoco*1, S. L. Annis1, S. T. R. Almeida2, B. C. Guimarães2, R. Hollandsworth3, M. Killerby1, C. Wu1, R. Kersbergen1, A. Lichtenwalner1, B. Perkins1, C. Knight1, D. Skonberg1, Z. X. Ma4, and J. J. Romero1, 1University of Maine, Orono, ME, 2University of Lavras, Lavras, MG, Brazil, 3University of Delaware, Newark, DE, 4University of Florida, Gainesville, FL.

Our objective was to evaluate the effects of an optimized lignosulfonate-based product (LST, UMaine), chitosan (ChNv, Sigma-Aldrich), and propionic acid (PRP, 99%; MP Biomedicals) on high-moisture alfalfa hay spoilage. Treatments were the factorial combination of 3 preservatives (LST, ChNv, and PRP) and 5 concentrations (0, 0.25, 0.5, 1, and 2% wt/wt fresh basis). Preservatives were added to 35 fresh g of sterile alfalfa hay (71.5 ± 0.23% DM), inoculated with a mixture of previously isolated spoilage fungi (5.27 log cfu/fresh g), and aerobically incubated in vitro for 23 d (25°C). Data were analyzed as a randomized complete block design replicated 5 times (5 independent plots from an alfalfa field) and differences were declared at \( P \leq 0.05 \). At d 0, the untreated hay had 43.9 ± 2.48, 19.7 ± 1.65, and 11.3 ± 0.17 of NDF, CP, and ash (% of DM), respectively. At d 23, relative to untreated (24.0 ± 0.45%), DM losses were greatly lessened by doses as low as 0.25% for both LST and PRP (~1.61). This was explained by reduced mold counts for as low as 1% LST (<2.0 log cfu/fresh g) and as low as 0.5% PRP (<2.0) vs untreated (6.76). Yeast counts were reduced by as low as 1% LST (<2.0) and as low as 0.25% PRP (<2.0) vs. untreated (6.10). Both as low as 0.25% LST and PRP prevented the decrease in DM (~62.5 ± 0.48%, 15.3 ± 0.12 and 24.1 ± 0.27% of DM). NH\(_3\)N was decreased by as low as 0.25% for both LST and PRP (~1.11 ± 0.77), and lower DM (~21.7) than PRP (23.6 ± 0.33%). CP was lower for PRP, NaL1, and NaL2 (~24.5 ± 0.42% of DM) compared with CON (27.4), and NH\(_3\)N (% of N) was higher for PRP and INO (~0.84) relative to other TRT (~0.50 ± 0.057). No major differences were observed for yeast (~4.27 ± 0.366) and mold (~2 log cfu/g fresh g) counts. Aerobic stability (h) was greater for NaL2 (103.2) relative to PRP (61.9) but no differences were observed vs. CON (90.1 ± 8.86). In conclusion, PRP preserved WBG nutrients during storage to the greatest extent, compared with the other preservatives tested.

**Key Words:** wet brewer’s grain, silage, preservatives

### 251 Meta-analysis of the effects of preservatives on hay spoilage I: Chemical treatments. M. Killerby*1, R. White2, D. C. Reyes1, A. Y. Le-on-Tinoco1, S. Rivera1, H. Paz2, J. A. Jendza4, and J. J. Romero1, 1Animal and Veterinary Sciences, School of Food and Agriculture, University of Maine, Orono, 2Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, 3Department of Animal and Dairy Scienc...
When producers are forced to bale hay above 20% moisture, large losses of DM and nutritive value, and the presence of mycotoxins can be expected. Our objective was to conduct a meta-analysis to evaluate the effects of preservatives on hay spoilage during storage. A literature search was conducted using the ISI Web of Science database where a total of 459 peer-reviewed papers were retrieved. For inclusion in the analysis, studies had to (1) be published in English language peer-reviewed journals; (2) concurrently examine untreated and treated groups; and (3) report the preservative application rate. Chemical preservatives were analyzed as a separate subset from microbial inoculants due to incompatibilities in application rate units (% vs. log cfu/fresh g, respectively). The chemical subset included 330 treatments from 50 articles. The metafor package of R statistical software was used to fit a multilevel linear mixed-effects model with response variable reflecting the standardized mean difference between treated and untreated for DM loss, sugars, and mold presence in hay samples within an experiment, within a study. Experiment and study were used as random effects. Moderators included forage type (FT: grass, legume, or mix); moisture class (MC: below 20% or above 20%); normalized application rate (AR); and preservative classification (PC). The 2- and 3-way interactions among these moderators were also tested. Final models were selected using a backward selection procedure where non-significant variables were removed iteratively if they were not involved in significant interactions. The final model suggested DM losses were significantly related to the interactions between FT and MC ($P = 0.044$) and between PC and AR ($P < 0.001$); and to the main effects of FT ($P = 0.001$), AR ($P = 0.050$), and PC ($P = 0.004$). A non-significant main effect for MC ($P = 0.355$) was also included in the model. Sugar concentration was affected by the 3-way interaction between PC, AR, and MC ($P = 0.032$); and by forage type ($P < 0.001$). Mold presence was affected by the 3-way interaction between PC, AR, and MC ($P = 0.0267$) and by the 3-way interaction between PC, AR, and FT ($P < 0.001$).

**Key Words:** hay, chemical preservatives, meta-analysis